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Impact of Marble Mining on the Environment and Ecosystem: A Case Study of Rajsamand District of Rajasthan (A Geographical Analysis)

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ABSTRACT

Marble mining is an important economic activity in Rajsamand District, Rajasthan, contributing to mineral production, employment, industrial development and regional economic activity. However, intensive quarrying and associated marble-processing activities have also created environmental and ecological concerns, particularly through land degradation, alteration of drainage, vegetation disturbance, dust generation and accumulation of marble waste and slurry. The present study examines the environmental and ecological impacts of marble mining with particular reference to the Morwad mining area and the marble-slurry dump yard at Mokhampura–Kelwa in Rajsamand District. The study is based on secondary data obtained from the government agencies and supplemented by field-based observations and published research. The analysis focuses primarily on changes in land use and land cover, environmental degradation associated with mining, and the implications of marble-waste and slurry disposal for soil, drainage, vegetation and surrounding ecosystems. The study indicates that quarrying and associated waste generation contribute to landscape modification through excavation, accumulation of overburden and low-grade marble, and disturbance of natural surfaces. Uncontrolled or inadequately managed marble slurry dumps may further contribute to dust dispersion, land occupation, runoff-related sediment movement and ecological disturbance. Site-specific research at Mokhampura–Kelwa has also reported tremolite asbestos fibres in sampled dump-yard dust, highlighting the need for mineralogical assessment and appropriate environmental safeguards. The study emphasises scientific waste management, rehabilitation of abandoned mining areas and ecosystem restoration as essential components of sustainable marble mining in Rajsamand District.

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KEYWORDS: *Marble Mining, Marble Slurry, Land Degradation, Land Use and Land Cover, Environmental Impact, Ecosystem, Dust Pollution, Rajsamand.*

INTRODUCTION

Rajsamand District, situated in the southern part of Rajasthan, is an important mineral-producing region of the state and occupies a distinctive position in the mineral-based economy of Rajasthan. The district is particularly renowned for its extensive marble deposits, which have contributed significantly to the development of mining, mineral processing, transportation, trade and allied industrial activities. Marble mining constitutes one of the principal economic activities in the district, providing employment opportunities, generating revenue and supporting the livelihoods of a large section of the local population. The interaction between mineral resource utilisation, industrial development, employment generation and environmental sustainability makes Rajsamand an important geographical region for studying the socio-economic implications of mining.

Geographically, Rajsamand forms part of the Aravalli mountain system, one of the oldest geological formations in India. Its geological structure contains a variety of mineral resources, among which marble

occupies a prominent position. The district's marble deposits have attracted mining enterprises, quarry operators, mineral traders and processing units over several decades. The availability of marble has encouraged the establishment of quarrying and cutting, polishing and finishing activities, creating an interconnected network of primary and secondary industries. Consequently, mining has become an important component of the district's economic structure and has influenced patterns of settlement, occupational diversification, infrastructure development and regional economic growth.

Rajsamand District is widely recognised for its marble production and quarrying activities. According to the district administration, Rajsamand is a major marble-producing district and is noted for its extensive marble industry. The development of marble mining has encouraged the establishment of numerous quarrying and processing operations, making the mineral sector an important part of the district's industrial identity.

Marble mining involves a series of interconnected activities, including geological exploration, extraction, block cutting, transportation, polishing, finishing and marketing. These activities generate economic opportunities beyond the actual extraction of minerals. Quarrying operations require workers for drilling, cutting, loading and handling, while processing units employ machine operators, technicians, electricians, mechanics and other skilled personnel. The transportation and marketing of marble further support drivers, vehicle operators, traders, contractors and commercial establishments. Thus, the marble industry contributes to the development of a broader industrial ecosystem in the district.

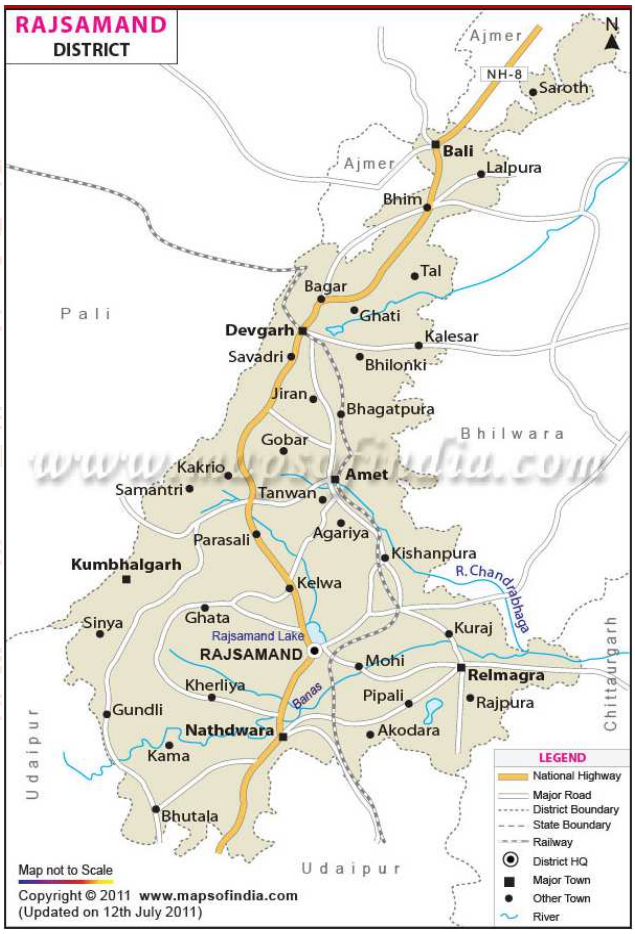
The marble industry also promotes entrepreneurship and investment. Small and medium-sized enterprises participate in quarry operations, mineral processing, equipment supply, transportation and trading. The availability of marble resources has encouraged the growth of ancillary businesses, including machinery repair workshops, construction-material suppliers and local service providers. These activities can stimulate economic diversification by creating non-agricultural livelihood opportunities, particularly in areas where mining and processing facilities are concentrated.

Marble mining contributes to public revenue through mineral royalties, dead rent, permit-related receipts and other applicable statutory payments. The industry also generates indirect economic benefits through wages, business transactions, transportation services and investment in industrial infrastructure. At the state level, Rajasthan's Mineral Policy 2024 identifies marble among the important minor minerals contributing to mineral-sector revenue.

At the district level, the economic significance of marble mining can be examined through indicators such as the number of operational leases, mineral production, royalty collections, employment, investment in processing units and the development of associated infrastructure. These indicators help establish the relationship between natural-resource utilisation and regional economic development.

Study Area

The study area of the paper is selected as Morwad Mining Area and Mokhampura – Kelawa, the marble slurry dump yard in Rajsamand District



Sources: map of India; https://www.mapsofindia.com

Objective of the Study

A. To assess the impact of marble mining on land use and land-cover patterns, particularly in relation to the conversion of natural vegetation, agricultural land and other land categories into mining areas.
B. To assess the extent of environmental degradation associated with marble waste and slurry disposal, including its potential implications for soil characteristics, drainage systems and surrounding ecosystems.

Result and Discussion

As per the *Rajsamand District Environment Plan*, the district covers approximately 4,655 km² and is situated within the Aravalli landscape of southern Rajasthan. Its terrain comprises elevated hills, rocky uplands, plains and valleys. The western and southern parts are characterised by the Aravalli hills, while relatively extensive plains occur towards the east. The district's average elevation is reported to be approximately 547 metres above mean sea level.

The district lies within the watershed of the Banas River and its tributaries, including the Khari, Chandrabhaga, Gomati, Kothari and Ahar. Many of these rivers and streams are seasonal and respond primarily to monsoon rainfall. The drainage network is influenced by the district's geological structures, fractures, joints and topography.

Climate : The district has a predominantly dry, subtropical climate, with hot summers, relatively cold winters and a concentrated monsoon season.

Sr. No.	Environmental Parameters	Reported value or characteristic
1	Climate	Subtropical dry climate
2	Average annual rainfall	567.8 mm
3	Rainfall concentration	Approximately 92% of annual rainfall occurs during June–September
4	Maximum summer temperature	May–June temperatures may exceed 47°C
5	Minimum winter temperature	December–January temperatures may fall to approximately 2°C
6	Principal rainy season	Approximately the second week of July to the third week of September

Source: Rajsamand District Environment Plan, geographical and climatic profile

Sr. No.	Component	Information reported in the District Environment Plan
1	Forest area	Approximately 25,952 hectares in the district profile
2	Common trees and vegetation	Dhok, babul, neem, khejari, peepal, banyan, gugal and other dry-region species
3	Other vegetation	Dhak, karonda, thor and associated scrub vegetation
4	Wildlife mentioned	Chinkara, leopard, fox, jackal, langur, peafowl and other fauna
5	Important ecological landscape	Aravalli hill ranges and associated forest habitats

Source: Rajsamand District Environment Plan, Section 1.6

Mining-office inventory	Marble leases/operations reported	Total mining operations reported	Area under mining
Mines, Rajsamand-I	515	644	12.15 km²
Mines, Rajsamand-II	260	549	36.03 km²

Source: Rajsamand District Environment Plan, Mining Activity Management Plan, pp. 53–54

Land degradation: Marble extraction requires the removal of rock and, where present, overburden and weathered material. Quarry development can create excavated pits, benches, exposed rock faces and waste-rock deposits.

Potential land-related impacts include:

1. Accumulation of overburden and low-grade marble.
2. Soil erosion and sediment movement from disturbed surfaces.
3. Changes in the appearance and ecological condition of the landscape.

As per Government details by the Department of Mines & geology, the no. of mining lease especially in extraction of mining has decreased in decade and in contrary the mining lease area has increased due to of closed and abandoned mines which are still in the status quo and there is no planning for abandoned mines and closed mines in terms to reduce the lad degradation.

Year	Minerals	Leases (in Nos.)	Area (in Hector)	Production (in Tons)
2016-17	**Marble**	**827**	**838.46**	**5877816.5**
2024-25	**Marble**	**766**	**1054.28**	**3538210.67**

Sources: Government of Rajasthan, Deptt. Of Mines and Geology, under Mineral Statistics

Relevance to marble mining: The hilly terrain and exposed geological formations provide the physical setting for quarrying. Excavation, removal of overburden, waste-rock deposition and modification of natural slopes may alter local landforms and drainage. These effects should be investigated particularly around mining clusters, drainage channels and adjoining agricultural land.

Marble quarrying can potentially affect the ecosystem through:

- Removal of vegetation and disturbance of soil and rock surfaces.
- Fragmentation of habitats and alteration of movement routes for wildlife.
- Increased dust deposition on leaves and other plant surfaces.
- Noise and human activity around quarrying and transportation routes.
- Changes in erosion and the physical characteristics of habitats.

The actual extent of these effects in Rajsamand requires spatial comparison between mining leases, forest boundaries, vegetation cover and wildlife habitats.

Impact on Environment & Ecology due to marble mining

Rajsamand District is one of Rajasthan's important marble-producing regions, where extensive quarrying and marble-processing activities generate substantial quantities of mineral waste. One of the major by-products of marble processing is marble slurry, a fine-grained residue produced during the cutting, sawing and polishing of marble blocks. It generally consists of finely divided mineral particles, predominantly calcium carbonate in the case of calcitic marble, mixed with water and, depending on the processing method, other residual materials. Marble slurry is commonly generated at processing units and may be transported to designated disposal areas or deposited in waste dumps. Inadequate storage, uncontrolled dumping and the absence of appropriate waste-management measures can create environmental pressures in the surrounding landscape. In Rajsamand, marble-waste management is therefore an important component of assessing the environmental sustainability of the marble industry.

One of the Reserch and sample collected from Mokhampura, Kelwa, in Rajsamand District. *Marble Waste Dump Yard in Rajasthan, and analysis revealed* reported that the presence of tremolite asbestos fibres in the sampled dust and also harmful and potential exposure concerns for workers and other people who might come into contact with the material.

The major impact of Environmental and Ecological Impacts of Marble Slurry Dumps are as under

- Air pollution and dust dispersion: When wet marble slurry dries, its fine particles can become susceptible to wind erosion and airborne dispersion. Dust may spread beyond the disposal site and settle on surrounding vegetation, agricultural land and other surfaces. The CPCB (Central Pollution Control Board) identifies deterioration of ambient air quality due to dust emissions from dried marble and granite slurry as a potential consequence of improper disposal.
- Soil degradation and vegetation impacts: The deposition of fine marble particles can alter the physical characteristics of the soil surface. Thick deposits may cover existing vegetation and interfere with normal soil–plant interactions. Dust

accumulation on leaves may also affect light interception and other plant functions, although the magnitude of such effects in Rajsamand requires site-specific ecological measurements.

- Surface-water and groundwater impacts: Uncontrolled slurry deposits may be affected by rainfall and surface runoff. The movement of slurry and associated sediments can potentially obstruct drainage channels and transport fine material into nearby water bodies.

Conclusion

Rajsamand District represents an important example of the relationship between mineral-resource utilisation and regional development in Rajasthan. Marble mining has contributed to industrial expansion, entrepreneurship, public revenue and the development of supporting economic activities. At the same time, its long-term developmental contribution must be assessed alongside its environmental consequences, occupational safety requirements and implications for traditional livelihoods.

Marble slurry dumping represents an important environmental-management challenge associated with the marble industry in Rajsamand District. Improper disposal can contribute to dust pollution, land occupation, runoff-related sediment movement and potential disturbance of surrounding vegetation and ecosystems. The investigation of the Mokhampura–Kelwa dump is particularly significant because tremolite asbestos fibres were reported in the dust sample analysed by the researchers, highlighting the importance of considering the mineralogical composition of marble waste alongside its conventional environmental characteristics. However, the findings from this particular site should not be generalised to all marble deposits or disposal locations in the district. Scientific waste management, pollution prevention, appropriate utilisation of slurry and ecological restoration are therefore important components of sustainable marble-industry development.

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